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2-D DIRECTION OF ARRIVAL ESTIMATION COMBINING UCA-RARE AND MUSIC FOR UNIFORM CIRCULAR ARRAYS SUBJECT TO MUTUAL COUPLING

R. Goossens and H. Rogier
Department of Information Technology
Ghent University
Sint-Pietersnieuwstraat 41, 9000 Gent
Roald.Goossens@intec.UGent.be; Hendrik.Rogier@intec.UGent.be

In various domains one notices a considerable growth of wireless applications. This results in an increasing number of users in mobile communication systems, although the radio bandwidth for wireless communication purposes is limited. This leads to interference between different users, which reduces the performance of the communication channel. The use of an antenna array enables us to estimate the direction of arrival (DOA) of all source signals that impinge on the array. The knowledge of the location of the different users in the communication system in combination with a beamsteering algorithm can cancel out the interference and improve the performance of the communication system, such as an increased channel capacity or a higher permissible number of mobile users.

In DOA estimation uniform circular arrays (UCAs) are very popular because of their circular symmetry. Several algorithms are developed to estimate the DOAs using UCAs. In most cases the effect of mutual coupling is neglected. The electromagnetic (EM) characteristics of the antenna elements in the UCA differ from the EM characteristics in the stand-alone case because the antennas are located in the near-field of the other antenna elements. Thereby, significant mutual coupling effects occur. When mutual coupling effects are not incorporated in the DOA estimation algorithm, less accurate DOA estimates are obtained.

To estimate the DOAs of the several users in two dimensions, being the azimuth angle as well as the elevation angle, we start from the eigenstructure technique MUSIC (MUltiple SIgnal Classification). To avoid a complicated 2-D search in the MUSIC spectrum we combine two eigenstructure-based estimation algorithms. First, we estimate the azimuth angles by applying the UCA-RARE (RAnk REduction estimator) algorithm. This algorithm estimates the azimuth angles of the source direction independently from the elevation angles without requiring exact knowledge of the element pattern, which is affected by mutual coupling. The knowledge of the azimuth angles enables us to find the elevation angles by investigating the classical MUSIC spectrum in a numerically simple 1-D search. To obtain the MUSIC spectrum a spherical mode-expansion of the open-circuit voltages is used to describe mutual coupling by means of a limited number of parameters. By considering a UCA which consists of nine dipole elements (operating at 900MHz) and a short-circuited dipole in the center of the UCA, we demonstrate that the proposed combination of algorithms provides accurate estimates for the DOAs in azimuth direction as well as in elevation direction.

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